AD 694656

DIGITAL COMPUTER NEWSLETTER

The purpose of this newsletter is to provide a medium for the interchange among interested persons of information concerning recent developments in various digital computer projects. Distribution is limited to government agencies, contractors, and contributors.

OFFICE OF NAVAL RESEARCH · MATHEMATICAL SCIENCES DIVISION

Vol. 20, No. 2 | Gordon D. Goldstein, Editor | April 1968
Laura A. Repass, Editorial Assistant
Barbara J. Walker, Editorial Assistant

CONTENTS

Approved by
The Under Secretary of the Navy
25 September 1961

NAVSO P-645

Editorial Policy Notices

EDITORIAL

Although the Digital Computer Newsletter is a Department of the Navy publication, it is not restricted to the publication of Navy-originated material.

The publication of information pertaining to commercial products does not in any way imply Navy approval of those products, nor does it mean that the Navy vouches for the accuracy of the statements made by the various contributors. The information contained herein is to be considered only as being representative of the state-of-the-art and not as the sole product or technique available.

CONTRIBUTIONS

The Office of Naval Research welcomes contributions to the Newsletter from any source. It is through these contributions that the value of the Newsletter is enhanced as a medium of exchange between government laboratories, academic institutions and industry.

A limitation on size prevents the publishing of all material received. Contributed items which are not published are kept on file and are made available to interested personnel within the government.

It is regretted that because of limited time and personnel it is often impossible for the editor to acknowledge individually all material received. It is hoped, however, that the readers will continue to submit technical material and suggestions to the editor for future issues.

Material for specific issues must be received by the editor at least three months in advance of the month of issue.

CIRCULATION

The Newsletter is published quarterly (January, April, July, and October) and is distributed, without charge, to interested military and government agencies, to contractors for the Federal Government, and to contributors of material for publication.

Requests to receive the Newsletter regularly should be submitted to the editor. Contractors of the Federal Government should reference applicable contracts in their requests.

All communications pertaining to the Newsletter should be addressed to:

GORDON D. GOLDSTEIN, Editor
Digital Computer Newsletter
Informations Systems Branch
Office of Naval Research
Washington, D. C. 20360

Computers and Data Processors, North America

GE 405 and GE 400 Time Sharing Systems

General Electric
New York, N.Y. 10022

The GE-405, latest and smallest member of the GE-400 "family" of medium-scale computers, was announced by the General Electric Information Systems Marketing Operation.

The GE-405 affords exceptional growth potential by permitting users to "build" their computer installations as their workloads increase. As the user feels a need for more memory and/or faster processor speeds, he may move upward to one of the other, larger members of the GE-400 series. If his needs include time-sharing, he may move into GE's newly-announced GE-420 time-sharing system.

Programs produced for any of the GE-400's are fully operational on larger systems in the family. A user may utilize original GE-405 programs as he later grows into the GE-415, the GE-425, and, finally, the GE-435 with extended memory, which ranges all the way to 131,000 words (524,000 characters). This eliminates the need for costly, time-consuming reprogramming problems when moving into a larger system, and permits the user to amortize his software development costs over a much longer period of time.

Language processors available for the GE-405 include COBOL, FORTRAN IV, Sort/Merge Generator, and Macro Assembly Language. These powerful language processors are efficiently utilized with the GE-400's Basic Operating System.

Application programs available for the GE-405 include the Scientific Inventory Management and Control System (SIMCON), Critical Path Method (CPM), Resource Allocation, Linear Programming, Math Pac mathematical and scientific programs, and a Generalized Payroll program.

With a memory capacity of 8,000 words (32,000 characters) and an access speed of two microseconds, the GE-405 leases for approximately $5,120 a month and sells for about $196,420.

Availability of the GE-405 is 4 months, with first deliveries scheduled for February 1968.

GE-400 SERIES OF MEDIUM-SCALE COMPUTERS

Specifications Common to GE-405, GE-415, GE-425, and GE-435 Computers

Electronics	Solid State
Decimal/Alphanumeric Character	6 bits
Word Length	24 bits and parity
Characters per Word	4
Memory Type	Coincident Current Core
Data Manipulation and Arithmetic	Decimal or Binary
Instruction Format	24 Bits Binary
Addressing	15 Bits Binary
Internal Data Storage	Decimal (BCD) or Binary
Number of Instructions	
Basic	70
Total Single- and Double-Address	200+
Addresses per Instruction	1 or 2
Number of Fixed Index Words	6
Maximum Number of I/O Channels	12

Features Common to All Four Computer Systems

- Multiple Read/Write/Compute
- Any Word Indexing
- Indirect Addressing
- Scatter Read/Gather Write
- Relocatable Accumulator

Program Packages for All Four Computer Systems

- FORTRAN
- COBOL Compiler

SIMCON
DAPS
Macro Assembly Compiler
Extended Operating System/Magnetic Tapes
Double Precision Floating Point
Report Program Generator
Sort/Merge Generator
Operating System
Input/Output System
Simultaneous Media Conversion
Service Routines

General Electric's family of GE-400 computers now includes four systems: the GE-405, GE-415, GE-425, and GE-435. Designed by one of the world's largest users of computer systems, the four are compatible in programming, peripherals, and hardware. They handle business data processing, scientific/engineering computations, and data communications assignments with equal facility.

The GE-400 systems have benefited from GE's intimate understanding of users' needs in operating economy, ability to expand promptly to keep pace with growing work loads, and the desirability of amortizing programming costs over as long a period of time as possible.

Users of GE-400 systems represent a cross section of business, industry, and government.

Built for ease of upgrading and expansion, the GE-400's have been improved periodically in speeds of operation and memory capacity, in line with the latest advances in computing technology. Development of new software and systems packages continues constantly.

For example, memory speeds—the time it takes to obtain data from the computer's memory—have been improved from 2.3 to 1.5 microseconds per character in the GE-415, and from 1.28 microseconds to 975 nanoseconds per character in the GE-425. The largest member of the series, the GE-435, has a memory of 680 nanoseconds per character; the newest and smallest member of the series, the GE-405, 2 microseconds per character.

Last April, it was announced that the core memory capacity of the GE-425 and GE-435 computers was increased from a maximum of 32,000 words to 131,000 words (524,000 characters) in increments of 16,000 words.

When a program is developed for the lower-capacity processor of any one of these computers, it may be used on any system with a higher capacity. Thus, programming investment may be charged against future growth as well as today's needs.

Recently, a Direct Access Programming System (DAPS) was announced for the GE-400's. It brought to users a medium-scale computers the ability to handle multiprogramming, remote operation, and long-distance communications. It provided many of the advanced capabilities usually found in larger-scale systems.

Another new application system for the GE-400's was also announced recently. Scientific Inventory Management and Control (SIMCON) provides the user with a means to automate inventory management and control, and was drawn from the inventory control experience of some 100 different General Electric product businesses covering a wide range of sizes and complexity. The new system enables many businesses to justify the cost of a computer installation solely on the basis of inventory savings and the resulting improvements in profits.

A new Extended Operating System for Magnetic Tape (EOS/MT) has been announced and already has helped one large national bank to increase its GE-415 throughput by 25 percent.

IC-6000 Computing System

Standard Computer Corporation
Los Angeles, California 90015

DESIGN APPROACH

From the beginning of their work in 1965, the designers and architects of the IC-6000 felt that the true potential of data processing could not be realized until several problems were solved. These problems were:

1. The seemingly inevitable need for costly reprogramming each time new hardware was developed.

2. The serious shortcomings of the new software which sometimes accompanied the new hardware.

3. The wasteful writing-off of proven and useful software systems just as they become truly productive.

Simply stated, they set out to find a way to cut the spectre of obsolescence down to size, or at least to soften or delay its impending impact.

The IC-6000 is their solution. It provides:

1. A machine-language-independent data processor having the capability to duplicate the instruction repertoire of virtually any other computer.

2. A data processor in which the machine language repertoires of a number of computers may be stored at various times to allow the execution of programs written for several different and incompatible computers systems.

3. A data processor with capability to include new and improved machine instructions which may be used in addition to or in place of regular machine instructions without the need for changes in the equipment.

4. A data processor system with capabilities such that it can be optimized for all types of problems.

5. An upward and downward compatible series of data processors capable of variable performance by tailoring system configurations to particular throughput requirements.

6. A data processor capable of executing higher level language statements without their first being translated into machine language.

7. A programmable man-machine interface, offering an improved operating environment and facilitating easy on-line program debugging, analysis, and diagnostics.

THE RESTRICTIONS OF PRE-IC-6000 DATA PROCESSING

The significance of the IC-6000 is best viewed in the light of the restrictive and provincial nature of present-day computer hardware design. The following three paragraphs of review make this clear.

Before a problem can be solved on a computer, a program consisting of a series of computational procedures must be written. This program must eventually be translated (either by a programmer or the computer itself) into a sequence of steps called machine-language instructions before it can be executed by the computer. The machine language of a particular computer is the collection of all permissible machine instructions it can understand and execute. The number, meaning, and format of these machine-language instructions varies greatly from one make or model computer to the next. For example, one computer system may have a machine language expressed in terms of 48 binary digits (bits), whereas another may be expressed as a variable number of 8-bit characters. Furthermore, one computer model may require only one instruction to tell it to take two numbers from memory, add them together and put the result back into memory. On the other hand, it might require three sequential instructions to perform the same computation on a different computer.

One of the most important qualities of a particular machine language is its ability to control communications between the various functional stations (memory, registers, arithmetic units, input/output devices, and so on). Generally speaking, in present day computer systems the relationships among the functional stations are frozen by the design and wiring of the system. Since the machine language format of a particular computer is generally predicated upon the logic and wiring of the system, such fixed relationships mean that a particular computer can execute only one machine language in an economical manner, and cannot utilize the full potential of each functional station.

As new and improved computing hardware is developed, it is imperative to use a new and improved format for the machine-language instructions in order to take advantage of the improved features of the new generation equipment. Thus the newer generation computing equipment will not understand and will not be able to execute directly programs written for the older generation computers. The user of older generation computers often finds it desirable to trade the older equipment for a newer model to benefit from the improved speed and computing techniques built into the newer equipment. In doing so, however, he often finds it costly and time consuming to rewrite his proven and useful programs so that they will run on the newer generation computer. A related problem is faced by users of large scale computer installations who have a number of computer systems. These computer systems frequently have different machine-language repertoires which are not compatible with each other. In other words, a program written for one computer system of the user will not perform on another computer system of the same user.

A NEW CONCEPT IN COMPUTER DESIGN

The IC-6000 may be described as a computer-within-a-computer. This novel concept eliminates the permanent bind between the various functional stations heretofore experienced in conventional computers due to the fixed wiring and logic of the system. In the IC-6000 all functional stations communicate with each other through the inner computer. This allows each functional station to behave in its most natural and economical fashion. The inner computer, having its own control memories, control units, and registers, can be set up to emulate the instruction repertoire and program capacity of virtually any new or prior art computer. This multilingual capability, implemented by a unique process called the MINIFLOW Emulation System, allows the IC-6000 to use existing program libraries without reprogramming or modification.

In keeping with the computer-within-a-computer concept, the IC-6000 should be viewed as divided into two parts—the external functional stations, and the inner computer. The external functional stations consist of the main memory, arithmetic units and registers, input/output channels, input/output devices, and the console. They perform the functions of similar devices on the computers being emulated. The inner computer, consisting of the scheduler, wired-in-sequence, control memories, translators, mini-instruction registers and decoders, indicators and display registers, and mini engine, takes the place of much of the wiring and control logic in a conventional system.

Programs written in the language of the machine being emulated are stored in the main memory. When the program is to be run, the inner computer fetches an instruction from the main memory, and performs the necessary indexing and indirect addressing operations by means of a MINIFLOW hardware sequence. The instruction is decoded and a MINIFLOW emulation routine in the control memory is entered which directs the inner computer through all the steps necessary to execute this particular instruction. The next instruction is then fetched from main memory and the entire process is repeated until the program is completed or terminated. Thus, the inner computer acts as an interpreter directing the IC-6000 system to respond just as though it were the computer it is intended to model.

BRIEF SYSTEMS DESCRIPTION

In this section one configuration of the IC-6000 system is described to acquaint the reader with the various functional stations. Detailed descriptions of each functional unit follow in the next two sections. Then the MINIFLOW emulation process as it is handled by the inner computer is described, showing how the functional stations work together to execute a program written for some other computer.

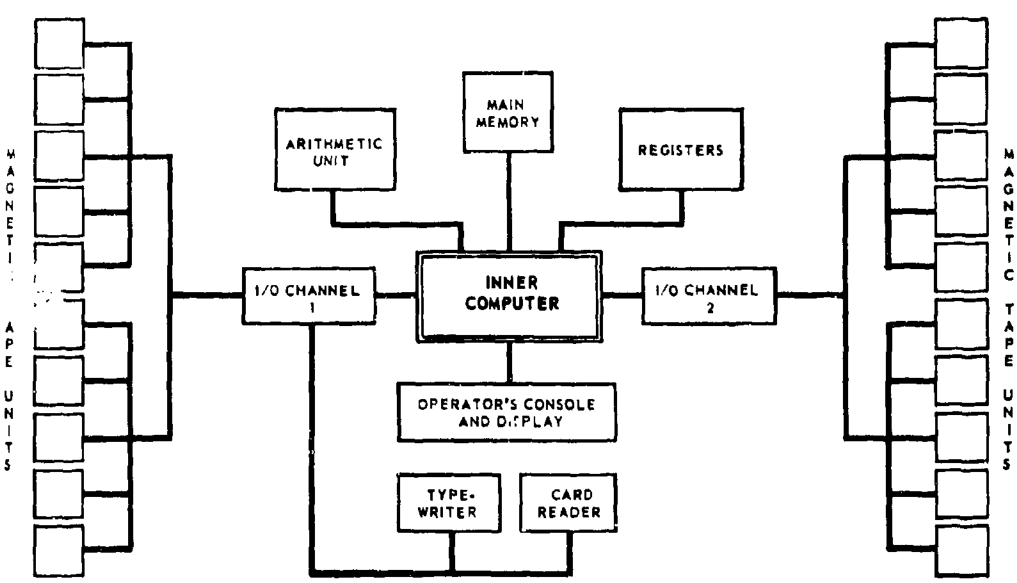

Fig. 1. - Typical IC-6000 system configuration

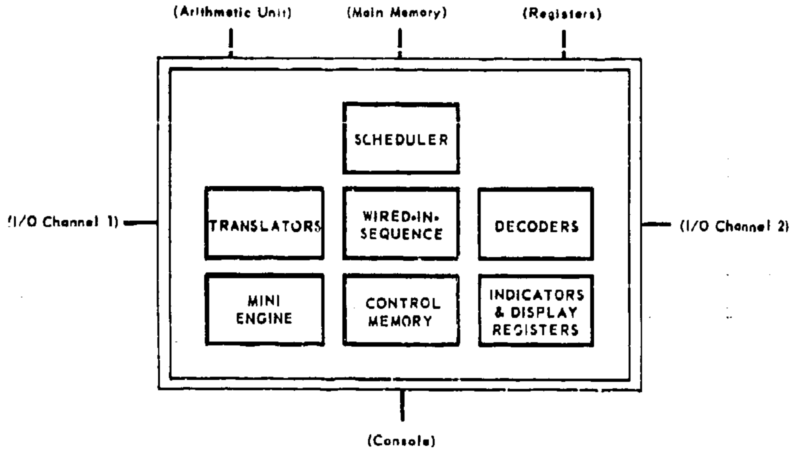

Fig. 2 - Major components of the inner computer

A typical configuration of the IC-6000 as it is used to emulate a well known second generation data processing machine consists of the inner computer with associated registers and control memory, and also external functional stations such as main memory, high speed registers, an arithmetic and logical unit, operator's console, and two input/output channels.

One channel typically controls a card reader, console typewriter and up to 10 magnetic tape units. The other channel typically handles up to 10 tape units.

Figures 1 and 2 show a typical IC-6000 configuration as outlined above and the major components of the inner computer.

EXTERNAL FUNCTIONAL STATIONS

Main Memory

The Main Memory functions as the core storage of the computer being emulated. It is used to store data and instructions which are in the form of a program in the machine language of the computer being emulated. The main memory typically contains 32,768 words consisting of 36 bits plus one parity bit.

Registers

The registers are high speed storage elements available to the operator and programmer on the same basis as those in the computer being emulated. The inner computer assigns certain functions to certain of the registers as required to duplicate those available on the computer being emulated. Typical assignments are: Accumulator (AC), 38 bits; Multiplier-Quotient (MQ), 36 bits; Index Registers, (XR1 through XR7), 15 bits each; Instruction Center (IC), 15 bits, and so on.

Artihmetic Unit

Arithmetic and logical functions such as fixed- or floating-point addition, multiplication, logical AND, OR, and masking operations are performed in the arithmetic unit. This unit is called the main engine, and is also used by the inner computer for internal operations.

Operator's Console and Display Unit

The operator's console simulates all the console functions of the computer being emulated. The console contains the keys, switches, and lamps necessary for manual and semiautomatic control and the visual checking of information in the system. Power to the system may be controlled from the console. All memory and register locations can be displayed. An execute entry function permits execution of console-keyed instructions without disturbing main memory. Address stop control provides several optional stop modes.

Input/Output Channels

The input/output channels control the quantity and destination of all data transmitted between the inner computer and the peripheral units. The channels may be considered small specialized data processors since they perform

their functions independently of the inner computer and independently of each other.

Peripheral Units

The peripheral units may consist of magnetic tape units, random access devices, card readers, punches, printers, typewriters, and the like. These are fully compatible with comparable devices on the computer being emulated. For example, the card reader or typewriter formats, where they differ from those of the computer being emulated are converted within the inner computer to a compatible format by means of a combination of hardware and software techniques.

INNER COMPUTER

Control Memory

The control memory contains 1,024 words consisting of 36 data bits and one parity bit. The control memory is used primarily to store MINIFLOW emulation routines, to store data and constants used by the MINIFLOW emulation system and the hardware while executing MINIFLOW instructions, and as a buffer area for data transmitted between main memory and the input/output channels. Control memory and the main memory are independent and fully overlapped, with the control memory functioning significantly faster than the main memory.

Scheduler

Since certain processes in the external functional stations may be taking place simultaneously, it is necessary for the inner computer to take action promptly when some device needs attention. This function is performed by the scheduler, which receives requests for action from the input/output channels, the operator's console, and from circuitry which indicates that a program in main memory is in progress. The scheduler passes control to certain entry points in the wired-in-sequence depending on the type and priority of the request honored.

Wired-In-Sequence

The wired-in-sequence contains certain wired sub-routines or sequences consisting of multiple program steps. For example, the purpose of one particular sequence may be to fetch from main memory the instruction to be emulated, decode it, and perform indexing and indirect address operations. Another sequence may be used to update the instruction counter and to fetch the operand or operands required by the instruction being emulated. Additional sequences may be used to save certain registers by storing them in predetermined control memory locations, when an interrupt or hang condition occurs in the MINIFLOW emulation process, and restore them at a later time. The scheduler will pass control to one of these sequences depending upon the type of request which has been honored. From there, the sequence is stepped from one state to another, although not necessarily in a sequential manner. Steps may be skipped within a sequence and control may be passed from one sequence to another.

Translators

The function of the translators is to decode the instruction being emulated and determine (by means of an entry table in control memory) the starting address of the MINIFLOW emulation routine necessary to complete the emulation; and to set certain general control elements in order to pass on specific information about instruction characteristics to the MINIFLOW routine.

Mini-Instruction Register and Decoders

The inner computer has its own highly specialized hardware-oriented machine language which is specifically designed for interpretive work. This is the language in which MINIFLOW emulation routines are written. An individual instruction in this internal language is 18 bits long and is called a mini-instruction. When a MINIFLOW routine is being executed, mini-instructions are brought from control memory to the mini-instruction register from whence the bit configuration is sent to the mini-instruction decoders. The decoders determine the operation(s) to be performed and send the appropriate control signals throughout the system.

Mini Engine

The mini engine is similar in construction to the main engine (arithmetic unit) except that no shifting operations (and hence multiply, divide, and floating-point operations) are performed. The mini engine controls shifting in the main engine, and contains its own registers.

Indicators and Display Registers

The indicators and display registers are sets of flip-flops and high speed storage

elements which are used to store hardware and MINIFLOW emulation program status, the occurrence of certain events within the system, and so on. The registers in this category include the display register, general indicators, and secondary indicators. Most of the bits in these registers may be individidally set or reset (or both) by mini-instructions, and many are connected to lamps on the operator's console.

THE MINIFLOW EMULATION PROCESS

For each instruction in the program of the machine being emulated (stored in main memory) the inner computer executes a routine or group of routines which are made up of sequences of mini-steps or mini-instructions. Similarly for each input/output operation and each console function to be performed, the inner computer executes still another set of routines. Most of these routines are stored in the inner computer's control memory, but for the sake of speed some of those which are used most frequently are "stored" or implemented into a portion of the logic called the wired-in-sequence. The entire collection of routines present in the inner computer at any one time is called a MINIFLOW emulation system. It is the MINIFLOW emulation system which tells the inner computer how to interpret the machine language instructions of any particular computer. It follows that in order to emulate a different computer, one has only to change the MINIFLOW system which, for the most part, consists of a program resident in control memory.

Specifically, here's how it works: In a typical sequence of operations, the scheduler passes control to the wired-in-sequence ("hard" emulation) which in turn passes control to mini-instruction execution ("soft" emulation). When mini-instruction execution is completed, control is returned to the scheduler.

When a program request is honored by the scheduler, control is passed to a certain phase of the wired-in-sequence. At this time, an instruction from main memory is brought to the main engine. (The address of the next instruction to be emulated is kept in the instruction counter register.) The operation code portion of the instruction is sent to the translators which generate an address pointing to a word in the control memory entry table. This word—the starting address of the MINIFLOW routine needed to complete the emulation—is sent from control memory to the mini engine. The address portion of the instruction is then modified if necessary by the index registers and indirect addressing. Another phase of the wired-in-sequence is then entered where the operands, if any, are brought from main memory or the registers to the main engine. A MINIFLOW emulation program is then executed starting at the control memory address specified by the word just loaded into the mini engine. When the MINIFLOW program is finished, an exit is generated which returns control to the scheduler. The process is repeated again when the scheduler honors another program request.

The above explanation is somewhat oversimplified, but should give the reader a general understanding of the way the inner computer interprets an instruction. It should be noted that not all instructions require the same wired-in-sequence operations, and a few instructions require no "soft" emulation. In addition, operations such as input/output and console functions which are not directly connected with the emulation of a specific instruction use a different portion of the wired-in-sequence and a different set of MINIFLOW emulation routines, but the process is somewhat the same as that described above.

SYSTEM ADVANTAGES

The most significant advantage offered by the IC-6000 is its ability to assume the identify of another system at a much lower cost. The IC-6000 can directly execute programs written for large scale systems with no conversion or reprogramming. It can run programs directly from cards or tapes used by the machine it emulates. It can use IBSYS, FORTRAN, COBOL, or machine language with no modifications whatsoever. And it can do these things at a very low throughput cost.

This means the user can conserve his investment in existing programs. He does not have to scrap his program library when he decides to convert to third-generation equipment. He does not have to reprogram at considerable cost. He does not have to emulate his old system on the new, at reduced efficiency and degraded performance. The IC-6000 offers a better, less expensive alternative.

The advantages of the IC-6000 emanate from its basic design concepts. The reason is simple: from the very beginning it was designed to use existing software efficiently.

Computing Centers

CHAOS: Chicago Asynchronous Operations Scheduler

Computation Center
University of Chicago
Chicago, Illinois 60637

CHAOS is the resident program in the IBM 7040 computer which is auxiliary to the IBM 7094, the main execution machine for the University of Chicago Computation Center. Its main functions are high speed input/output, task scheduling for both the 7094 and 7040, and the provision of utilities. Of general interest are the task-file concept (which greatly simplifies scheduling); the scheduler (which cooperates with the operators in task scheduling); and the dynamic disk storage allocation scheme (which contributes both to general efficiency and ease of recovery in the event of system failure).

For the present discussion, it is sufficient to know that attached to the 7040 are card readers, card punches, printers, disk storage, a direct connection to the 7094, and tapes switchable between the 7040 and 7094 under program control. Also attached to the 7040 are direct connections with the MANIAC III computer at the Institute for Computer Research and the 1401 computer in Billings Hospital.

An understanding of CHAOS must include an awareness of five practical criteria underlying its design.

1. Maximum Throughput. The foremost of these was that the unit record equipment be worked to the limit in getting 7094 jobs through the system. This aim has been successfully accomplished and the card reader, punches, and printers all run at full speed. At present approximately 500 jobs per day pass through the system with turnaround time rarely exceeding 1 hour, and often less than 15 minutes.

2. Schedulability. A second decision was that CHAOS should have complete flexibility in scheduling the processing of input and output files and not be bound to a "first in, first out" schedule. This decision devolves from a consideration of operator ease and turnaround time—particularly the latter. Turnaround time is the interval between job submission and completion, and upon this interval rests the effectiveness of a programmer's work day. It is a long standing practice at the Computation Center to favor debugging runs when the programmer is on the premises. This frequently results in larger turnaround times for production runs. CHAOS contains a scheduling module which can be easily altered or replaced (see Scheduler below).

3. Ease of Recovery. A third criterion was ease of recovery in the event of operator or system error. Without adequate recovery procedure, hours of processing could be lost (see Checkpoint and Recovery, below).

4. Operator Control. A fourth criterion was that the operator can, in any instance, override a scheduling decision made by the system. Under CHAOS, the operator exerts control over the system by typing commands on an input/output typewriter. In addition to being able to alter the status of task-files, the operator can set system parameters (such as the time of day) and attach or detach I/O devices.

5. Provision of Utility Functions. It was felt that only rarely would the 7040 be monopolized by its primary functions (the generation, scheduling, and processing of 7094 input/output) and would be able to perform utility functions as well. Thus CHAOS contains a utility monitor which provides facilities for card reproducing with editing, card listing, tape listing, card to tape operations with updating, assembly, and loading (of systems programs). Utility functions are given lowest priority.

Designing CHAOS according to the above criteria involved several operational models, each containing refinements over its predecessors. Considerable difficulty was encountered in realizing the throughput potential of the hardware and at the same time providing scheduling and adequate recovery procedures.

---

*The CHicago Asynchronous Operation Scheduler, CHAOS, was designed and developed at the University of Chicago Computation Center by Paul Kosinski, Vincent Kruskal, Edward Kubaitis, Clemens C. J. Roothaan, Michael Williams, and William S. Worley, Jr.

I. TASK-FILES

A task-file is a file of data in disk storage upon which a task is to be or has been performed. How task-files are created and processed will be clearer after following a typical 7094 job through the system.

1. The job deck enters the system through the 7040 card reader and is transcribed to the disk, thus becoming a "7094 input task-file." When the scheduler (or the operator) is ready to send the job to the 7094, the task-file is copied to the 7094 input tape attached to the 7040. At the completion of the current 7094 job, tapes are automatically switched and the job is run. When completed, tapes are switched again.

2. The packed output tape is copied to the disk, thus becoming the "7094 packed output task-file." When the scheduler is ready, a portion of the file is brought into a 7040 buffer and unpacking begins. Data to be printed are sent back to the disk as a "print task-file" and data to be punched are sent as a "punch task-file."

3. When the scheduler (or operator) is ready to print the output, the "print task-file" is fed to a printer, a line at a time.

4. Similar treatment is accorded the "punch task-file."

Normally the generation of several task-files and the processing of existing task-files proceeds simultaneously.* This is accomplished by passing control back and forth between a central supervisor routine and several peripheral subroutines, each charged with either the creation or the processing of a given task-file. In relation to a given subroutine, it is the supervisor's responsibility to cause entry at precisely the right time and to avoid both premature entry (which would retard the activities of the other subroutines) and late entry (which would retard the task of the given subroutine). Correct timing is achieved by clocks maintained by the supervisor, and by traps.

After a task-file is processed, it remains in the system (usually for several hours) until the space it occupies on the disk is needed. This permits the operators to request reprocessing of task-files (e.g., in the event of a hardware failure).

II. SCHEDULER

A task-file normally passes through four stages: (1) being built, (2) ready, (3) in progress, and (4) done. A task-file being built will automatically pass to the "ready" stage unless the task requires physical setup† (in which case the task-file enters "waiting for setup" status). A task-file in "ready" status moves to the "in progress" state as an automatic function of the Scheduler; for a task-file in "waiting for setup" status, the provision of setup information for the operator is scheduled by the Scheduler, but the task-file does not enter the "in progress" stage until the setup instructions are acknowledged by the operator.‡

The scheduler has two complementary local objectives: the first is to provide "reasonable" service to as many users as possible, rather than optimal service to a few; the second objective is to push as many tasks through the system as possible in a given interval. As the work load changes from light or moderate to heavy, the scheduler's concern gradually shifts from the first objective to the second. Thus, as the work load becomes heavier, shorter tasks are given preference. As the work load lightens, the service accorded to shorter tasks is somewhat degraded in order to give "reasonable" service to both short and long tasks.

The scheduler does not, for the most part, distinguish between setup and non-setup tasks in pursuing the objectives described above.

Normal scheduling (i.e., according to the scheduling algorithm) is bypassed for any tasks the operator selects for early processing and for those tasks where the user has indicated his

*For example, at a given time two task-files for the two card readers may be under construction while seven task-files are being fed to the three printers and four punch hoppers. The example can be expanded to include the sending of input to or receiving of output from the 7094, activities of the utility monitor, and so forth.

†For example, tape mounting, special printer forms, special cards, and so on. Setup is specified by job deck control cards and this information is sent to the operator at the proper time.

‡In addition to the normal releasing of task-files from "waiting for setup" status, the operator can effect a variety of other status changes. For example, he can cause a task to be repeated by restoring the task-file to "ready" status or he can cause a task-file to be put in "held for operator" status. Task-files in the latter status are not scheduled and cannot be processed until moved to "ready" status by the operator.

willingness to pay a premium (high priority) rate. Both are pushed through the system as fast as possible.

III. DISK STORAGE ALLOCATION

Four checkpoint files occupy fixed locations in disk storage. The remainder of the disk is for task-files and the Utility Monitor. This space is allocated dynamically as new task-files are written over task-files already dropped from the system.

Task-files may be of arbitrary length, being spread over an arbitrary number of tracks. Each track, containing about 450 words, includes information identifying the task-file along with the addresses of the immediately preceding and succeeding tracks (if any) occupied by the task-file. This "chaining" together of tracks facilitates backward and forward spacing.

To reduce seek time, tracks are allocated (for a given task-file) from bottom to top (from the available tracks) within a cylinder. Should a task-file exceed the space available within its cylinder, the file continues on the lowest available track of the next available cylinder. All tracks for a given task-file are confined to one disk module, thus insuring that it can be processed entirely even though the other module should be inoperative.

Maps showing disk storage allocation are contained in core tables. When one of these tables becomes "full," they are revised so that references to a number of the oldest, already processed task-files are dropped and the tracks occupied by the dropped task files are made available for receiving new task-files.

The general effect of the disk allocation scheme upon seek time can be estimated by observing the movement of the disk arms. During a peak activity period, most of the arm movements are confined to a band of approximately 2 inches. New task-files are being created on the inmost cylinder of the band and existing task-files being read lie towards the periphery. Two or three times a minute, a longer seek is made for writing a checkpoint file. As time passes, the band of arm movements gradually shifts towards the center. Under lighter workloads, the band is correspondingly narrowed.

IV. CHECKPOINT AND RECOVERY

To provide partial defense against disasters resulting from operator or hardware indiscretions, checkpoint files containing system status information are maintained in four fixed disk locations. Each time there is a change in the core tables containing system status information, the need for writing a checkpoint file is registered and a checkpoint file will be automatically written on one of the four fixed locations, the choice of which (for successive checkpoints) being determined cyclically. The checkpointing subroutine, however, has low priority with the effect that checkpoint files are written only about three to four times a minute.

In the event of system failure, recovery is effected by reloading CHAOS from tape. CHAOS restores to core the most recently written checkpoint tables and scans them for tasks "in progress." Any such tasks are recommended and the system continues, hopefully sustaining little injury.

HASP Operating System

University of Kentucky
Lexington, Kentucky 40506

The University of Kentucky is currently running much of its 360 closed shop on a new system called HASP (Houston Automatic Spooling and Priority System).

In order to demonstrate the difference between HASP and previous systems some of the devices on the S/360 and how the previous systems used them must be described.

The printer on the S/360 can print 900 lines a minute or approximately one line every 67 milliseconds. If the information to be printed were placed on a direct access device such as the 2311 rather than the printer, then 10,800 lines could be placed on the disk per minute. Therefore, writing the output on a disk is approximately 12 times as fast as writing the same information on a printer.

One outstanding problem occurs when this is done. All the user's output is now on the 2311. The output must be read from the 2311 and printed. It would seem that in doing this all the time gained by putting it on the 2311 in the first place would be lost; however, the S/360 has another feature which prevents this loss. The S/360 can do Input/Output operations, such as reading information from a 2311 at the same time it is performing computations.

Two programs could be placed in the 360 memory at the same time. One which reads lines from disks and prints them (HASP) and a user's program which does computations. The two programs would run as follows.

HASP would issue a command to the S/360 to start reading 12 lines from disk (this may take a millisecond) then while it is waiting for the S/360 to read these 12 lines) about 65 milliseconds) the user's program can be processing data. When the S/360 has read the 12 lines HASP will instruct the S/360 to start printing the 12 lines, and while it is waiting for the lines to be printed (about 780 milliseconds) the user's program can be processing again. Therefore, about 778 milliseconds out of every 780 are made available to the user's program while the 12 lines are being printed. The time used in actually printing is hardly noticeable.

If HASP can print a line while computations are being performed why couldn't the user's program be printing. The user's program can, and in most cases, if the program is written in FORTRAN, does. For most user's programs (and the compiler), however, the computations done between printing each line are considerably less than 65 milliseconds, maybe only 1 or 2 milliseconds. Therefore the user will print a line, do a millisecond of computation, and then want to print another line, but the next line cannot be printed until the previous line has been printed. So the user's program must wait 64 milliseconds while the line is being printed. In other words, about 98 percent of the time available to do computation is not used.

In HASP, when the user wants to print a line, since the line is actually going to the 2311, there is only a wait of 5 milliseconds (20 percent of the available time is being used) which is a considerable improvement.

The above explanation of how HASP saves time was over simplified, but should give some idea of the time saved. Another thing which makes HASP fast is that it also uses the above process for reading and punching cards.

What kind of jobs will run best under HASP? Short programs and compilation which do little computation and a lot of printing. Jobs which do large amounts of computation and little printing will not be improved by HASP; however, while such a job is running HASP can be printing the output from another job.

The efficiency of HASP will be increased shortly with the addition of another printer. With the extra printer HASP can be printing output from two jobs simultaneously. Also in the near future UK will be getting a faster direct access device. With this device HASP will increase its speed from 1200 lines a minute to 5000 lines a minute.

(The figures used in this article are not accurate since several factors have been ignored. Therefore, they are only used to indicate how the HASP system saves time rather than how much time is saved.)

Computers and Centers, Overseas

Cartographic Digitiser for Computer

d-mac, Ltd
Glasgow, S.W.2, Scotland

An electronic device, the d-mac Cartographic Digitiser Type CF, has been developed as an aid to reducing vast amounts of data—obtained over many years of field survey and cartographic work—to a form suitable for computer processing. It is manufactured by d-mac Limited, Queen Elizabeth Avenue, Glasgow, Scotland.

Providing a rapid means of digitising selected information contained in maps, charts, drawings and photographs, the Digitiser becomes a key unit in the growing employment of computers for the analysis of problems relating to conservation of natural resources and food production.

The first two units have been supplied to the Canadian Department of Forestry and Rural Development for the reduction of map records needed to assist in the generation of a computer data bank. By means of this, all relevant information will be immediately available as basic material for government decision-making on land utilisation.

Pictorial data are placed or projected on to the Digitiser's Reading Table; using a Reading Pencil, the operator traces outlines or selects individual points to be digitised; an automatic sensing device beneath the reading surface follows the Pencil accurately and position signals are passed to the Electronics Console where they are displayed and converted into a suitable form for feeding the output unit.

The Cartographic Digitiser derives from the d-mac Pencil Follower Trace Analyser which is currently used in the major universities and the scientific and industrial research establishments of 20 countries.

Because of the complexity of cartographic data, the new digitiser has been designed with a large range of input modes and outputs.

Maps and charts are divided into areas contained within coastlines, contours or other boundaries. When analysing with a computer, it is necessary to define these boundaries and what is contained within them. The Cartographic Digitiser has three main input modes to handle this information.

In operation, the Cartographic Digitiser has three main modes for input: "line," where X and Y coordinates are passed continuously to the output unit while a line is followed smoothly, for example when digitising coastlines or contours or defining areas; "position," where one coordinate set is entered when the Pencil is pointed at a particular spot, such as the position of a town; and "manual," where an electric typewriter, fixed address, and other facilities are used to enter alphanumeric information such as the names of towns or population densities.

The volume of digital information required to define a boundary line is so great that it is advantageous to record it on magnetic tape, which has a high-packing density.

Punched cards or tape are ideal for recording positional information and alphanumeric information pertaining to particular areas, such as soil density or population. The cards are particularly suitable for easy filing and sorting.

An electric typewriter gives the digital information in tabulated form for presentation or checking.

Controls have been engineered to allow the simplest possible operation. Mode functions and the output media are selected by push buttons and the unit incorporates both audible and visual warnings to ensure that it is operated correctly.

A Cartographic Digitiser has been supplied to the Experimental Cartography Unit at Oxford, England, sponsored by the Natural Environment Research Council of Britain, where it is being used as a compilation reader for a system of automatic map production in conjunction with a computer.

Another has been ordered by the technical advisers to the Royal Dutch Shell Group. Installed in their office in The Hague, it will be

used for digitising a variety of graphic information such as well logs, contour maps, seismic sections, oscilloscope pictures, and load diagrams of well pumps.

Although the Digitiser was specifically designed for cartographic applications, it can also be used in numerous other fields of research. These include:

Engineering. Ship design, piping layouts, road design and quantity surveying.

Aerospace research. Analysis of engine vibration records, telemetry recordings from satellites, kinetheodolite and high-speed films.

Medicine. Analysis of electrocardiograms, x-ray films, blood flows, microbiological assays and polygraphs.

Environmental Research. Analysis of hydrological and meteorological data.

Scientific applications such as particle track analysis in nuclear physics.

Ferranti BOAC Information Display System

Ferranti, Ltd
London, England

The automation Systems Division of Ferranti Ltd. have delivered and commissioned the first of BOAC's 30 Argus Computer Information Display Systems ordered for use with the airline's complex of 3 IBM System 360/65 Central Processors recently installed at London Airport. The £33-1/2 million project, known as Boadicea, will meet all BOAC's computer needs, consisting initially of aircraft seat booking, inventory control and accounting, until the late 1970's.

Each Information Display System consists of a large number of electronic typewriter keyboards from which interrogating messages are sent to the Central Processor over specially adapted telephone lines. The reply is written automatically on the screen of a Ferranti C.R.T. Display Set.

The first installation will be used to train seat reservations clerks and other operating staff. A second training system will be commissioned by Ferranti Ltd. at BOAC's Park Avenue, New York, premises towards the end of this year. The other 28 systems which employ over 600 Display Sets, will be delivered during 1968.

A unique method is used by the Company to produce writing on the Display Set screens. The displayed letters and numbers are selected by the Argus microminiature computer, and the computer programme is also used to control the actual formation of the characters on the screen.

Ferranti Information Display Systems will eventually be introduced in some 50 BOAC and Associated Company's offices throughout Europe and North America.

New ICT 1900 Series Computers

International Computers and Tabulators Limited
London SW15, England

Following the policy of continually enhancing the I.C.T. 1900 Series of computers, I.C.T. announces new processors suitable for both commercial and scientific applications—the 1901A, the 1902A, the 1903A, the 1904A, and the 1906A. All these new systems which incorporate the latest integrated circuit technology offer features increasing the flexibility with which they may be used, and which were previously associated with larger and more expensive computer systems.

All these new systems are full members of the 1900 Series, and, therefore, fully compatible with each other and existing members of the Series. They are capable of using the range of I.C.T. 1900 peripheral devices. The extensive software already developed for the 1900 Series is available; it includes compilers for all the standard languages, operating systems, and applications packages providing standard methods of coping with problems common to all sections of industry, such as payroll, production control, stock control, critical path planning, financial forecasting, engineering calculations, and so on. These new processors, as with all the 1900 Series, permit modular growth in step with customers' growing data processing requirements.

I.C.T. believes that it has caught the rising tide of advance in integrated circuit technology at just the right moment. The circuitry employed in these new processors, TTL (Transistor Transistor Logic) supersedes earlier

developments in that it exploits the possibilities of integrated circuits rather than copying the logical arrangements of conventional component circuitry.

In much the same way that the 1901—of which I.C.T. have already sold more than 400—represented a breakthrough in the market for small and medium sized organisations, the 1901A brings direct access computing within the range of these users. A simple 1901A system will market for less than £35,000 whilst a viable 1901A direct access system based on a new I.C.T. twin-disc will be available for less than £50,000. New computer users will be able to start with direct access computing which will make it easier for them to build up to larger real-time systems based on direct access. The advantages of direct access systems are: (1) it is easier to convert commercial systems to automatic processing; (2) new data can be processed as it arises; (3) a number of files can be marked at one time without having to arrange the files in a special sequence; and (4) information can be read direct from any position in a file.

A further contribution to the low price of the 1901A direct access system is a new peripheral device—the I.C.T. twin-disc. Additional savings in the 1901A have been achieved by connecting the basic peripherals—disc, card reader, and line printer—directly to the central processor. Standard interface peripherals may of course also be attached to the 1901A.

1902A AND 1903A

With the 1902A and 1903A systems I.C.T. is providing advanced computing facilities at a much lower cost than was previously possible. The 1902A, with configurations costing in the range £80,000 to £200,000 offers in its larger configurations multiprogramming facilities which enable four programs to be carried out simultaneously, thereby making optimum use of all parts of the system and greatly increasing the throughput of work. The 1903A, costing from £130,000 to £400,000, is suitable for use at the centre of large scale, real-time data processing networks. Both the 1902A and the 1903A use advanced operating systems including facilities to handle conversational computing on nine remote consoles.

1904A

The 1904A is an extremely powerful computer and offers full multi-access facilities, and multi-programming of up to 16 programs. Prices range upwards from £300,000. The I.C.T. operating system, George 3 which copes with the throughput of batch processing and multi-programming work, will be used on the 1904A. The 1904A complements the existing E and F processors which are maintained in their present form in the Series.

1906A

The 1906A, which will have more than twice the power of Atlas, is the most powerful computer fully committed for production by a British manufacturer. It offers a unique combination of advanced hardware technology, and I.C.T.'s unmatched experience in the development and use of large-scale operating systems. Prices will range from £0.5 to £1.5 million and deliveries will commence at the end of 1969.

Orders for some 40 machines for universities, research centres, Government departments, and large commercial and industrial organisations are anticipated. In addition, the 1906A forms an integral part of the I.C.T.'s giant machine proposals to the Government, exploiting fully the growth opportunities within a completely compatible range.

The 1906A incorporates a number of features new to the 1900 Series. New circuit technology is used to give exceptional computing power. The high speeds of fully integrated circuits based on Emitter Coupled Logic (ECL) are exploited fully by a new method of matched inter-connections developed by I.C.T., based on multi-layer platters. This, coupled with the provision of a fast, interleaved core store and an instruction overlap facility, makes possible processing speeds in the order of 1 million instructions a second.

Another new feature is that of paging, originally pioneered on the I.C.T. Atlas, it is offered as an option. Paging is a method of organising the storage of information to make more flexible use of core store and a fast drum store, and to give greater flexibility of programming. Among other things, this will make it easier to put large scale multi-access systems into operation.

To the commercial user, the 1906A offers speed, improved cost-effectiveness, and the ability to handle large quantities of data. It will transfer information between the central processor and the peripheral units at rates of 5 million characters a second. Thus it will be able to handle large numbers of peripherals including very fast devices such as a new drum operating at 1.5 million characters per second. For

the scientific user the high calculation speeds will be important and these can be further enhanced by the addition of special high speed mathematical units. All multi-access users will benefit from the availability of paging and of a full range of communications equipment enabling the 1906A to handle large numbers of communications links.

It is significant that the 1906A will be a fully compatible member of the 1900 Series. Over 900 of these computers have already been sold with some 500 already in use in industry, commerce, research, and Government, around the world. Programs developed by these users and the full range of I.C.T.'s software will work on the 1906A. In addition, special programs fully exploiting the 1906A's power will be provided. I.C.T.'s experience in producing standard computer programs, the software which reduces the programming burden on its customers, is unmatched.

The compatibility of the 1906A will also make it easier to build computer networks. Other 1900's already installed may be linked in hierarchical networks so that only the most complex problems are passed up to the 1906A.

DELIVERIES

Two 1901A's are fully operational now at I.C.T.'s Stevenage laboratories and the first 1903A was recently installed at I.C.T.'s Putney computer centre. Deliveries, depending on the configuration chosen will be in the region of 9 months for the 1901A/2A/3A and 2 years for the 1904A, the first deliveries of the 1901A will be made early in August this year.

Miscellaneous

Smithsonian Institution Preparing History of Computers

American Federation of Information Processing Societies
New York, N.Y. 10017

The Smithsonian Institution in Washington, D.C., is embarking on a long-term research project leading to the first complete history of computers. An initial grant to support the project during the next two years has been made by the American Federation of Information Processing Societies (AFIPS), representing over 40,000 computer professionals in the United States.

Dr. Bruce Gilchrist, President of AFIPS, said in making the announcement, "In its brief 21 years of existence, the electronic digital computer has come to be called one of the most important inventions in man's history—but the history of the computer itself is becoming obscured and lost because of the incredibly rapid rate of technological change in the industry. The computer history project, in the hands of the Smithsonian Institution, will assure that the full story of the origins and development of the computer will be objectively recorded and told."

Overall supervision of the research project will be provided by Dr. Robert P. Multhauf, Director of the Smithsonian's Museum of History and Technology, and by the President of AFIPS. Dr. Uta C. Merzbach, Curator of Mathematical Instruments at the Museum will be the Principal Investigator in direct charge of the research activities.

"One of the vital elements in the research," Dr. Multhauf stated, "will be the collection of oral interviews with the key contributors to the early development of computers. All recordings, as well as written, photographic, and other materials collected and developed, will be retained in the Museum of History and Technology in the public domain. The collection phase will take about 5 years, with an ultimate objective of developing a publishable history of computing."

Dr. Multhauf added that the use of calculating machines predating the electronic computer would be included in the research project. "The Museum has had a substantial effort underway in the history of calculating and computing machines," Dr. Multhauf said, "but we can now accelerate and expand our research in this area with the financial assistance of AFIPS."

A five-man Advisory Committee has been named to assist in the conduct of the research. Committee members are:

- Mr. Isaac Auerbach, Auerbach Corporation, Philadelphia, Pennsylvania
- Dr. Cuthbert Hurd, Computer Usage Company, Inc., Palo Alto, Calif.
- Mr. R. A. Winnacker Department of Defense, Washington, D.C.
- Dr. Walter F. Cannon, Museum of History and Technology, Smithsonian Institution, Washington, D.C.
- Dr. Bernard S. Finn, Museum of History and Technology, Smithsonian Institution, Washington, D.C.

Computer Aided Instruction

Diocese of Brooklyn
Catholic Schools
Brooklyn, New York 11201

The computer, educational television, and the telephone have been teamed up in a unique experiment to provide individual instruction to 70 parochial school teachers in Brooklyn and Queens.

One night a week, the teachers turn on their classroom TV sets to watch a half-hour lecture. Then they call in to a remote computer and use their push-button phones to take a multiple-choice quiz and hear an evaluation of their answers.

After the test, the teachers request more information about subjects covered in that evening's lecture through their telephones. To reply, the computer has been programmed to select the appropriate recorded message and illustrate it with a related TV picture flashed on the teacher's television screen.

The series of video-taped lectures entitled "The World of Computers" is part of an educational experiment being conducted by the Catholic Schools of the Diocese of Brooklyn with the technical assistance of International Business Machines Corporation.

Brother Austin David, FSC, the Diocese's data processing consultant, said the purpose of the 8-week telecourse is to learn more about the practicality of using a computer with television as a means of providing individualized instruction.

An IBM System/360, located at IBM's Mohansic Laboratory in Yorktown Heights, N.Y., is linked by telephone lines to special equipment in the Diocese's educational TV studios at Bishop Ford High School in Brooklyn.

The video-lectures are beamed into Diocesan schools over one of four educational TV channels operated by the Diocese. These are 2,500-megacycle channels licensed for instructional purposes only, and cannot be received on home television sets without special receiving equipment.

During the computer-assisted part of each lesson, Roman Catholic nuns, brothers, and lay teachers in nine schools use standard push-button telephones to:

- Take a test on what they have seen and heard during the lecture.

- Find out how they scored on the test and how to review any points that were missed.

- Ask for recorded voice explanations which review and expand the topics covered in the lecture.

- Request recorded explanations illustrated by still pictures on their classroom TV sets.

Here is how the experimental system works:

After viewing the lecture, the teachers place a phone call to the computer at a pre-assigned time. The computer is programmed to present each teacher with a series of pre-recorded multiple choice questions based on the lecture content and drawn from messages stored in its experimental audio-response unit.

To answer a question, the teacher presses one of the 12 buttons on a push-button telephone. After each response, the computer announces over a speaker-telephone whether the teacher's answer was correct or incorrect. If incorrect, the computer automatically selects an additional voice message telling the teacher where to find more information on that topic during the review period that follows.

After the last question, the computer's program provides a list of suggested makeup topics based on the teacher's incorrect responses.

The teacher can elect either to review the subjects suggested by the computer, or choose other topics of interest from a course outline. Each topic has a code number, and the teacher selects the subject matter by entering this number through the keyboard of the push-button telephone.

In response to each request, the computer is programmed to pick an appropriate pre-recorded voice message. For teachers who use the combined audio/video expanded lecture, the computer also automatically selects one or more pictures stored in a slide projector at the educational TV studio. These pictures are transmitted over one of the Diocese's channels and appear on the classroom TV screen.

Four teachers at a time can communicate with the IBM System/360, Model 40. Three of them receive only voice messages, while the fourth gets both voice messages and TV pictures during the review period.

Using their push-button telephones, teachers can interrupt any message from the computer. They also can ask for a repeat of the whole message or part of it, or move on to a new topic of their own choosing.

If a teacher enters a wrong number and then realizes her mistake, the entry can be cancelled and corrected. Invalid entries are automatically detected by the computer which responds with a special error message.

Teachers have 20 minutes to explore topics of their own choice. Then they take a second test similar to the first to determine what progress they have made.

After the experiment is over, the progress of teachers working with the computer will be compared with that of control groups who simply watched the lectures or took pencil and paper tests.

The Diocese and IBM also hope to learn more about the learning process by studying the search patterns used by teachers in requesting expanded lecture material.

USING THE SYSTEM

Teachers participating in the educational television experiment being conducted by the Catholic Schools of the Diocese of Brooklyn communicate with an IBM System/360 Model 40 through standard 12-key push-button telephones. A plastic template, which fits over the push-button telephone keys, identifies special functions such as "repeat message" and "cancel message" giving the teacher added flexibility in working through the expanded lecture.

Voice messages from the computer are provided through the telephone by an experimental voice-response unit. This unit contains pre-recorded voice messages which can be selected by the computer in answering a user's request.

In the experiment, each teacher watches a half-hour TV lecture about computers. After each lecture, teachers dial up the computer and key in their identification number. The computer replies as follows:

"In this part of the lesson, you will be asked to answer some questions. For each question, choose the one answer you think best. Key in the digit corresponding to your answer. If you don't know the answer, guess."

Next comes a series of 15 to 20 multiple-choice questions about the evening's lecture. For example:

"Credit for the invention of the binary number system as we know it today is given to:

1. Pascal
2. Babbage
3. Leibnitz
4. Babylonians

If the teacher knows the right answer, Leibnitz, and keys in number 3, she hears:

"Your answer is correct."

But if she keys in another answer, the computer responds:

"Your answer is incorrect, Information about this topic may be found in selection 147"

When the test is over, the computer summarizes the selection numbers which correspond to incorrect answers:

"The following is a list of the selections you may wish to consult in the expanded lecture: 147, the life of Leibnitz. . . ."

The expanded lecture contains many selections which can be used by the teachers in different ways. It can be used for review purposes by teachers who request more information about the topics recommended by the computer. The expanded lecture also can be used for obtaining more information about topics of interest to the participating teachers. The computer starts off in this manner:

"Welcome to the 'World of Computers.' This series is being brought to you by the Catholic Schools of the Diocese of Brooklyn, in co-operation with International Business Machines Corporation. The present program deals with the material covered in the fourth telecast, entitled, 'The Magic Numbers, 0 and 1.'

"Before we begin, please be sure that your content outline for this lecture is easily accessible for quick reference. If you have a particular topic already selected from your outline, you may enter its number at this time. Otherwise key in 106."

The message for Selection 106 lists several general areas which the teacher may explore and a code number for each general area. When one of these codes is entered by pressing telephone push-buttons, a more detailed topic index with additional codes is heard. The teacher selects one of these codes to listen to an expanded treatment of any specific topic. As indicated in the opening message, the teacher can also choose a selection from the list in the course outline and select this topic directly.

Suppose the teacher decides to review selection 147 which was recommended by the computer because she missed the question about binary numbers; by keying in 147 the teacher hears the message:

"Gottfried von Leibnitz is credited as the inventor of the binary number system. Leibnitz was a German mathematician who lived from 1646 to 1716. Actually many people had been using the binary number system for many years, but no effort had been made to present the ideas of the binary number system in a systematic manner. It was Leibnitz who achieved this.

"However, the mathematicians of his era were not too impressed with the binary number system, and it was not until the advent of the digital computer that the ideas and thoughts of Leibnitz on this topic were appreciated.

"For a discussion of the binary number system, select 146.

"To see how the binary number system is related to the modern electronic digital computer, select 126."

One group of teachers participating in the experiment receives a combined audio/video expanded lecture. These teachers see a picture of Leibnitz on the television screen while listening to the message.

The picture comes from a slide stored in a random access projector in the educational television studio. A special control unit in the studio receives a signal over telephone lines from the computer and causes the projector to select the slide and project it into a TV camera. The picture is then transmitted over one of the 2,500-megacycle educational channels operated by the Diocese.

Most of the expanded lecture selections, like the one above, conclude by giving codes for one or more related topics from which the teacher can choose if interested.

For example, if the teacher decides to investigate the relationship between binary numbers and the modern computer, and keys in 126, she hears this passage:

"Binary numbers consist of only ones and zeroes. It is easy to see that these two states correspond to the on-off situation that occurs in electrical circuits. Thus the flow or pulse of electric current could be interpreted as a binary one, and the lack of a pulse as a binary zero.

"The modern electronic digital computer contains thousands of automatic electrical switches that are used to transmit our binary numbers. Since they can be either on or off, they can be used to correspond to a binary one or zero. The electrical activation of these switches permits information to be transferred within the computer and to be processed according to instructions.

"This concept of the on-off circuit as related to the binary numbers allows the computer to count and compute. If an electric pulse goes through a circuit, a count of one is registered. These pulses occur at the rate of millions per second.

"For a discussion of the binary number system, enter 146.

"To see how this concept of the binary number is related to the various input devices of the computer, enter 127."

The television picture reinforcing this passage shows a pair of simple electrical circuits—one switched on and the other off and indicates how these conditions correspond to the binary one and zero.

Teachers participating in this phase of the telecourse have 20 minutes to select expanded lecture subjects. At the end of this portion the computer terminates the lesson as follows:

"You have completed the time alloted to you for this phase."

At this point, the teacher takes a re-test similar to the first one to see what progress she has made. This time, however, the computer states the correct answers to any missed questions.

Finally, after the re-test, comes the concluding message:

"You have completed the lesson for this week. Please hang up your telephone and call again at your next scheduled time. Thank you."

THE SPECIAL EXPERIMENTAL TV IMAGE BUFFER

To demonstrate that a single television channel can provide different still pictures to many viewers at the same time, a special device that captures and holds single images has been installed on one of the classroom TV sets used in an educational experiment conducted by the Diocese of Brooklyn with the aid of International Business Machines Corporation.

The experimental unit, called a keyed buffer by IBM engineers, records each new picture received from the TV station and retains it on the screen even after the station stops broadcasting it.

Anyone watching the channel on an ordinary television receiver would see the picture only for an instant as it flashed on the screen. But at Mater Christi High School, one of nine Diocesan schools involved in the experiment, a viewer watching the buffered receiver sees the picture appear and remain steady on the screen.

The reason is that this standard TV receiver is connected not directly to an antenna but to the keyed buffer. Once the buffer has recorded a new picture transmitted from the educational TV station of the Diocese, it is continuously displayed on the TV screen until another picture is transmitted from the station and recorded by the keyed buffer.

According to Roger C. Greenhalgh, manager of education programs for IBM's Advanced Systems Development Division, keyed buffers working on the same principle could enable an educational television station to provide customized material to many viewers, at different locations at the same time, over the same educational TV channel.

Still pictures transmitted by the station could be coded, or addressed, to a particular TV set, Mr. Greenhalgh said. The buffer associated with that TV receiver could be adjusted to record only pictures addressed to it. Pictures addressed to other TV sets would not be recorded.

* * *

Three Dimensional Computer Created Pictures

Brown University
Providence, Rhode Island 02912

A computer here is creating pictures, as simple as a cube and as complex as a refinery pipeline, that can be seen in three dimensions.

The computer, an IBM System/360 at Brown University, can produce a pair of images, differing slightly in perspective, side by side on a television-like screen. By looking at the screen through a special viewer, a person sees the two images merged into one with the added dimension of depth.

The images, geometric models stored in the computer's memory, can actually be manipulated on the screen—enlarged, reduced, moved up or down, or rotated.

In addition, a person can alter the pictures generated by the computer by moving a light-sensitive device called a light pen across the screen. Straight lines and points can be drawn and erased with the light pen without altering other parts of the picture.

Dr. Walter Freiberger, professor of applied mathematics and director of Brown's computing center, says that the use of a computer to create three-dimensional pictures has great potential for industry.

"The petroleum industry, for instance, might be able to end the laborious process of building an actual model of each refinery it plans to construct," he says.

"Right now scale models are constructed to check that the thousands of pipelines required for a modern refinery don't run into one another. It may be possible to do the same job—at a great saving in time and money—by giving the data in architectural plans to a computer and then inspecting the three-dimensional results on the screen."

The experimental 3D project at Brown has been undertaken by Charles M. Strauss, a graduate student, and Dr. Andries van Dam, assistant professor of applied mathematics, who is supervising this doctorate work in the Division of Applied Mathematics.

Mr. Strauss created a program, a set of special instructions for the university's System/360 Model 50, which enables the computer to display information on the 12- by 12-inch screen of an IBM 2250 display unit.

Because the results are to be three-dimensional, the program must, in effect, construct two pictures of each object, one for each eye. The special viewer, called a stereoscope, uses mirrors and prisms to merge into one the two slightly different images that are produced.

Manipulating the pictures on the screen—making them bigger or smaller, rotating them or moving them up or down—is accomplished by pressing various keys on the display unit. The "window" through which the objects displayed on the screen appear to be viewed can be moved by the viewer in order to "zoom" in for a closeup of a part of an object.

Accredited Computer Aided Course

Florida State University
Tallahassee, Florida

A computer at Florida State University, as part of a rigidly controlled experiment, has begun teaching introductory physics to a class of 30 freshman students. This is believed to be the first accredited college course being taught fully by computer.

Conducted under a U.S. Office of Education grant, the experimental course was designed by FSU to examine student reaction to it and to measure its effectiveness against the lecture method.

The course is part of a research program started at FSU in 1963 with the formation of its Computer-Assisted Instruction (CAI) Center, here. According to Dr. Duncan Hansen, director of the Center, "our purpose is to examine the computer's potential to help teachers teach in the midst of the growing population-and-knowledge explosions."

FSU's new computer is an IBM 1500 instructional system. Engineered into it is the seemingly contradictory capability to teach students separately in a group.

The 1500 is specially designed for educational use. It has three major elements:

- A computer, or central processor, that directs its operations

- Interchangeable electronic files, which hold the "textbook" for the course and instructions for the computer, and

- A series of TV-like terminals, equipped with typewriter keyboards and electronic "light pens," which constitute the learning stations.

The FSU system has eight terminals on which the computer projects instructions, information, questions, and reacts so rapidly to the answers that each student appears to be "conversing" privately with it. Twenty-four additional terminals will be installed by the end of the quarter.

The content of the experimental CAI physics course is the same as that being taught to more than 500 other FSU freshmen in regular classroom lectures. The difference is that the computerized version is rigidly structured, put into machine language—called programming, and all conceivable alternatives, even wrong answers, are incorporated into the logic flow.

It is the logic flow that directs the instruction—jumping students that are progressing quickly, providing hints or remedial work, when necessary, and generally keeping the students from outwitting the machine.

There are 29 basic lessons in the computer-based physics course. About 50 percent of the course material will be presented by the computer, the rest from reference material and audio-visual aids to which the computer directs its students. The computer also issues homework assignments.

At the same time the computer is teaching, it is compiling records of student progress; these records will be checked regularly by CAI Center staff members.

There are no regularly scheduled classes for the experimental course. Students in the pilot group, who are volunteers from the conventional physics class, have 9 hours a day of computer time available to them.

Final grades will be based on mid-term and final examinations, the same tests given to students in the regular basic physics classes this term.

The automated course will not be repeated next quarter. Dr. Hansen and his staff will evaluate the course material and students' reaction and make any necessary revisions before offering it again.

The final result of the FSU project will be a research report to the Office of Education. Dr. Hansen thinks it may also produce a self-contained, fully automated, basic physics course which could be made available to colleges and universities where there are too few students to form a class or a shortage of physics teachers.

A Program Package for Computer-Assisted Text Editing and Data Retrieval

National Bureau of Standards
Washington, D.C. 20234

A major problem in the extension of computer techniques to the processing of scientific manuscripts, either for editing and automatic typesetting or for storage and retrieval, is the limited number of characters on the ordinary computer printer, card punch, and typewriter. The problem is not insurmountable and has been met with varying success.

Recent developments in hardware and programming should soon provide a capability to handle text with scientific notations, such as subscripts, superscripts, Greek letters, mathematical and logic symbols, and diacritical marks present in some languages.

It is not economical, nor even necessary, for computer printers to provide authors with the nearly 1,000 symbols available to printers who specialize in scientific publications. A computer line-printer component with 240 distinct characters and having provision for

half-line spacings offers enough flexibility to cope with all but the most specialized situations.

Early in 1968, the Office of Standard Reference Data will have access to such a computer. This line-printer will have 240 distinct characters, will be able to provide half-line spacing for subscripts and superscripts, and will be able to print several characters in the same position (e.g., / imposed over 0 gives Ø).

Computers can accomplish easily and efficiently a variety of tasks encountered in editing, printing, and revising data compilations. They can modify or refine text (delete unwanted information or instructions); select, abridge, or rearrange lines or blocks of data or text; format the final printed pages; and, finally, build a table of contents and an index.

A number of text editing programs for these purposes now exist, and others are being developed.*,†,** Not only can "editing" problems be solved, but they can be solved in such a way as to produce simultaneously a general-purpose data retrieval system of considerable power and flexibility.

A suitably designed editing program serves still another important purpose—that of providing a simple means of coping with different data formats. Such a program makes the transformation of data or text files from one format to another a trivial task, and thereby reduces the necessity to force heterogeneous files into rigid formats.

A package of utility programs for computer-assisted editing (Edpac) with the above-mentioned characteristics and objectives is being developed by the Office of Standard Reference Data in collaboration with some of its associated data centers at NBS. The first computer programs of this series will be described in a forthcoming NBS publication.††

*Text 90, by J. C. Sekora, International Business Machine Corp., Dept. D78, Poughkeepsie, N. Y. (June 10, 1965).

†FORMAT, a text processing program, by G. M. Berns, IBM Washington Scientific Center, 11141 Georgia Ave., Wheaton, Md. 20902 (July 1967).

**Computer-assisted text preparation, by J. Hilsenrath and K. Waibel, Technical Report TR-67-47, Computer Science Center, University of Maryland, College Park, Md. 20742 (July 1967).

††Edpac: Utility programs for computer-assisted editing, copy-production, and data retrieval, by C. G. Messina and J. Hilsenrath.

The first release of Edpac contains FORTRAN program listings and descriptions of five programs: JUSTIFY, SCRAMBLE, SEARCH, BLOCKSEARCH, and SUBSTITUTE. These may be used independently or in sequence.

Any editing system which permits the deletion or addition of substantial segments of text must have some provision for rearranging the words into lines of specified length. JUSTIFY is a text formatting program which provides this facility with or without justified right-hand margins. It can center lines of text, indent, and perform other features useful in preparing camera-ready copy; however, the program does not hyphenate words at the end of a line. When line justification is called for, the extra spaces are placed first after each period in the line and then between the words, starting from the left in one line and from the right in the next. Because simplicity of use is an important factor in the design of these programs, the rules are kept as conventional as possible. For example, the start of a paragraph is ordinarily signaled by leaving at least one blank space at the beginning of the line, just as a typist might indent when starting a new paragraph, or by inserting a blank card which is equivalent to leaving a blank line when paragraphs are not indented.

SCRAMBLE provides for the substitution of any single character for any other. It is equivalent to a simple substitution cipher. It is used in the transformation of variables, in the conversion of one precedence symbol to another, and in character transformations in linguistics research.

The program called SUBSTITUTE is a more versatile and correspondingly more complex program. It has a provision for replacing any character string by any other character string regardless of where it occurs in the text.

Among the diverse jobs this program can do are the following:

1. Convert text punched on cards in BCD format (all capital letters) to upper and lower case, such as initial capitalization of the start of each sentence and authors' names and initials.

2. Replace any arbitrary set of symbols by corresponding instructions for a phototypesetting machine.

3. Recognize typesetting instructions in a text and either delete them or replace them with other codes.

4. Anglicize test written by Americans.

5. Replace journal abbreviations by their five letter CODEN designations or vice versa, or by the full title.

6. Match citation numbers in the body of a paper with an indexed list of references.

7. Insert complex mathematical expressions when they occur frequently in a text, thereby avoiding needless retyping and subsequent proofreading.

8. Insert typesetting instructions in place of code words for special symbols not available on the input device.

9. Screen and correct automatically inconsistent use of abbreviations or symbols.

SEARCH and BLOCKSEARCH are useful for data retrieval. The first program searches a card image of a single line of text for the presence of <u>any</u> or <u>all</u> of a group of words or strings or fragments; it prints out the line or punches out a card when such items are located.

BLOCKSEARCH is able to scan an entire block of lines, making it generally more useful in data retrieval. This search is made not on a single line, but on a suitably delineated block, such as a paragraph, a page, a full bibliographic citation, or an abstract. On a successful match the entire block is printed or punched.

An important feature of both searching programs is the ability to handle fragments such as prefixes or suffixes or even fragments in the interior of words. Ordinarily the scanning is anchored to the beginning of the word. For example, asking for the word "thermo" would produce lines with thermodynamics, Thermodynamics, thermochemistry, and Thermochemistry. If the program is set to the unanchored mode, it will locate the word Aerothermodynamics as well. In this search mode, imbedding a blank (Δ) at the end of a string restricts the search to endings or suffixes. Thus, when asked to locate FLEXΔ, the program will find CELLUFLEX, but not FLEXIBLE. Set to locate all lines containing both of the strings ΔCEL and LEXΔ, this program would locate all words beginning with CEL and ending with LEX, such as CELLS and COMPLEX.

The Edpac programs have been written in FORTRAN with considerable care to avoid any machine-dependent instructions so as to permit the direct use with the various computers utilized by the NBS data centers. The programs run without modification on the IBM 7094, the CDC 3600, the UNIVAC 1107 and 1108, and the IBM 360/30.

Computer Typesetters to "Learn Math"

National Science Foundation
Washington, D.C. 20550

Computers can already set type for ordinary books, where the sentences run smoothly on one line from one side of the page to the other; however, math text stumps them.

Although any fifth-grader can write a fraction or put an exponent on a number, computer typesetters still have to learn to place figures in raised or lowered positions or to center the numerator over the denominator.

The American Mathematical Society, Providence, Rhode Island, is now tackling this problem, one of the most challenging in the development of computer typesetting, with the aid of a $152,000 grant from the National Science Foundation. The Foundation hopes that the project will make possible increased speed and efficiency in supplying scientific information to scientists.

A good system to instruct the computer how to handle complicated text should appreciably reduce the time necessary to set type for scientific journals. It should also simplify production of a machine-readable record of the contents of the journals so that abstracts, indexes, and selections of specific pages of material could easily be made.

The American Mathematical Society is devoting 14 months to designing and debugging the necessary computer program and typesetting equipment, including a Photon disc—an opaque wheel perforated with mathematical signs and symbols through which a computer-guided beam of light passes to print the desired symbol on a light-sensitive photo-offset plate. Part of the time will go for testing the new system on 150 pages of difficult mathematical text.

Gordon L. Walker, executive director of the Society, is the principal investigator for the project.

* * *

State-Wide Police Information Network

Ohio State Highway Patrol
Columbus, Ohio 43205

A potent new weapon that fires instant, accurate information, soon will be used by State and local police in Ohio to track down criminals.

The new weapon is a computer-base police information system and state-wide electronic communications network. In a split second, it will retrieve from a central file information on such things as stolen cars, stolen property, and certain wanted persons and guns used in connection with crimes.

The system, called LEADS, for Law Enforcement Automated Data System, will be in use early in 1968 by State Highway Patrol and local sheriff and police departments.

Colonel Robert M. Chiaramonte, superintendent, Ohio State Highway Patrol, said, "Use of computers in this manner on a state and national level probably represents the greatest advance in police information and communications since the radio."

Typewriter-like terminals, to be installed in law enforcement agency communications centers throughout the State, will provide direct access to computers in Columbus, IBM System/360s, containing three separate files of information:

1. Registration numbers and related data on the more than 5-million Ohio licensed vehicles;

2. Basic operator's license information on the 6-million, or more, drivers licensed by the State of Ohio, including current records of any arrests, convictions, or traffic violation points compiled;

3. A file of information on such things as stolen vehicles and parts, missing license plates, and vehicles driven by persons with suspended or revoked operator's licenses.

"This type of information," said Colonel Chiaramonte, "has always been available; however, the system brings it together for the first time so that it can be put to effective use."

Access to the files will be restricted to authorized law enforcement personnel who require the information to carry out their duties.

The terminals also will provide communications between law enforcement agencies within the State. Acting as a switching center, the IBM computer will enable persons using the terminals to communicate with any one, or all of the 155 terminals in the system.

"The value of having correct information available quickly can be measured in terms of human lives, increased traffic safety and dollars," said Colonel Chiaramonte.

For example, he explained that a policeman will be able to find out before he approaches a vehicle if it has been involved in a serious crime, such as a bank robbery, or if it is stolen.

To obtain the information, he will radio the car's license plate number to a dispatcher in his communications center. The dispatcher will enter the number through a terminal. Within seconds the computer will answer and the dispatcher can radio the response back to the policeman.

Thus, the policeman's chances of being unprepared when he approaches a car driven by an armed, or dangerous person are greatly reduced.

Checking on revoked, or suspended operator's license, also will be accomplished using the terminals to access data in the central computer file.

"About 50,000 operator licenses are suspended or revoked in Ohio annually," said Colonel Chiaramonte. "Nearly one-half are due to accumulation of traffic violation points.

"Greater apprehension of these people, who represent a hazard to other motorists, can result in increased traffic safety on our city streets and highways," Colonel Chiaramonte said.

The Bureau of Motor Vehicles expects to have full information of this nature on computer file for every licensed driver by October 1968.

The three computers to be used for LEADS are operated in Columbus by the State Department of Finance. They include an already installed IBM System/360 Model 30 and a Model 40. A second Model 40 is expected to be installed shortly.

The files of information will be contained on four IBM 2321 data cell drives, each capable of holding 400-million characters of information, and two IBM 2311 disk storage drives.

LEADS will enable Ohio to tie-in to the National Crime Information Center in Washington, D. C., run by the Federal Bureau of Investigation. The files stored there by the FBI on an IBM computer include current information on stolen property, wanted persons, guns, and stolen vehicles in all states. The information is available to all law enforcement agencies in the country.

LEADS also will provide a link to the Law Enforcement Telecommunications System. This nationwide system enables police units in each of the 48 continental states to exchange information rapidly and aid each other in the apprehension of criminals.

Colonel Chiaramonte pointed out that while the State Highway Patrol will administer LEADS, it will be guided by a policy committee representing the Ohio police and sheriff departments.

Commenting on the value of LEADS, Colonel Chiaramonte noted that it will enable police to disseminate information rapidly on the 27,400 vehicles stolen each year in Ohio. It now takes three days, or more, just to notify all state units of a theft.

Colonel Chiaramonte noted that 10 percent of all stolen vehicles go unrecovered, representing an annual loss of $2.1-million.

An increase in recoveries of only 1 percent would benefit Ohio citizens by $274,000 a year.

Explaining the use of the National Crime Information Center in Washington, Colonel Chiaramonte said, "Initially, Ohio stolen property files will be stored in the IBM computer there." Information includes the brand name of the property and its serial number.

In developing LEADS Colonel Chiaramonte said 170 Ohio sheriffs and police departments participated in a survey to determine their needs for such a system. In addition, 26 police chiefs and 25 sheriffs representing various sizes of law enforcement agencies in the State were interviewed.

A study was also made of other computerized systems in use throughout the country for law enforcement.

Colonel Chiaramonte noted that small law enforcement agencies in Ohio counties which do not include, or are not near, a terminal-equipped communications center will be able to form county communication centers. In the sparsely populated, rural areas of the State, two or three counties may share a joint communications center.

Larger cities in Ohio that may develop police information systems will be able to tie-in to LEADS.

In this manner, every radio equipped car in the State could have access to computer files within seconds.

Computerized Law Status

State of Pennsylvania
General Assembly Data Processing Center
Harrisburg, Pennsylvania

When a Pennsylvania legislator in the State Capitol Building here wants to know the current status of a proposed law, he'll be able to ask a computer, and get his information in seconds.

An IBM System/360, containing detailed data about all bills before the General Assembly, began serving senators, representatives and their aides in October 1967. Information produced by the computer also will be available to members of the press.

Daily reports on pending legislation will be available from the computer at a number of locations in the State Capitol Building, either as text flashed on a television-like screen or in printed form. These up-to-date reports could be used to replace a printed document now issued to state lawmakers once a week.

In the State Capitol Building, two kinds of communications devices will be linked to the System/360. They are IBM 2260 display units, which show information on a cathode ray tube; and IBM 1053 communications terminals, which type out the information on a modified electric typewriter.

"The most important benefit of the new system will be the availability of up-to-date information," says Regis D. Steighner, executive director of the General Assembly's new Data Processing Center.

"The traditional method of keeping track of pending legislation has been to publish what is called a 'short title'—a record of bill status and history. By the end of a busy week, this 'short title' is likely to be out of date.

"The computer will have the facts stored in its memory updated daily. We plan to have a fresh report available before the General Assembly convenes each morning."

The IBM System/360, a powerful Model 40, is located in the General Assembly Data Processing Center in the State Capitol Building.

* * *

Computer Aided Instruction of German

University of Southern California
Los Angeles, California 90007

How computers are teaching German to college students in a successful experiment that may become nationwide has been described by Dr. Harold von Hofe, chairman of the German department at the University of Southern California.

For more than 3 years, teaching material written in German by the USC professor, has been used at the IBM Computer Research Center at Yorktown Heights, N. Y., in a telephonic link with students at the State University of New York at Stony Brook.

This is the first computer-assisted instruction program in a foreign language dealing with understanding, speaking, reading, and writing. Students work at typewriter consoles and "talk" with the computer whenever they have trouble. The computer points out errors and suggests ways of correcting them without making the corrections itself.

Because each student may work at his own pace and must work each exercise correctly before he can go on to the next unit, the only difference between good and poor students is the amount of time spent, Dr. von Hofe said.

"The computer can do drill work with students better than a human being," the USC professor said. "It does not become impatient or nervous.

"The learning of German involves repetitious drill and incessant practice of structural patterns. Whereas the burden of drilling students and supervising pattern practice has fallen upon the language teacher up to now, we are on the threshold of removing that burden from the teacher.

"Teachers will be freed from oral work and will have more time to deal with the culture of the language area they represent.

"Language teaching will become more humanistic and have a broader cultural orientation, if properly planned, than heretofore.

"Computers are capable of performing sophisticated teaching if we instruct them to do so in a sophisticated manner," von Hofe predicted.

"In an age of standardization, the computer can serve as a tool of individualized tutorial instruction because each student works by himself with the computer. In no educational institution does a teacher have the time to spend hours every day, as a computer does, with each of 20 or 30 students in a class. The computer is a boon to the slow learner as well as the rapid one."

* * *

Jovial (J3) Standard Programming Language

System Development Corporation
Santa Monica, California 90406

Adoption of JOVIAL (J3) as the Standard Programming Language for Air Force command and control applications has been announced by the Air Force's Directorate of Command Control and Communications.

JOVIAL, a machine-independent, general-purpose programming language developed by System Development Corporation (SDC), will be used as a standard only for new Air Force command and control systems. Adoption of the language does not mean existing systems must be reprogrammed to meet the JOVIAL standard, an Air Force spokesman pointed out.

In adopting JOVIAL (J3), the Air Force also established standard specifications for the development of compilers, and established a means of updating the language and specifications to incorporate future developments in

programming languages that may be used in command and control applications.

Details of the programming language standard was recently published in Air Force Manual 100-24. According to the manual, JOVIAL (J3) "answers the pressing need for a common standard of communications among the users of many different computers.

"As a common programming language, JOVIAL serves both as a means of communicating information processing methods between people and as a means of realizing a stated process on a number of different computers."

The manual includes specifications for requirements for design, test, performance, and qualification of JOVIAL (J3) compilers.

JOVIAL, developed by SDC in 1958 for use by the Air Force in the SAGE (Semi-Automatic Ground Environment) air defense system and other large-scale command/control systems, is an acronym standing for Jules Own Version of the International Algebraic Language. The language is also used by other branches of the armed services, and has had numerous civilian applications as well.

* * *

Teletype Inktronic Page Printer

Teletype Corporation
Skokie, Illinois 60076

The Inktronic page printer that forms characters from electronically controlled jets of ink at speeds of 120 characters per second (1,200 words per minute) or less, was unveiled in November 1967.

The receive-only printer, which will be available in limited quantities in mid-1968, is part of a complete line of high speed data communications equipment.

According to Teletype Corporation officials, an Inktronic KSR (keyboard send-receive) set will be available toward the end of 1968. Plans call for including tape processing capabilities in the future as well as increased speeds for complete utilization of voice grade channels.

Printing is done on ordinary teletypewriter paper, an important cost-saving feature in view of the unit's extremely high operating speed. Major applications include use for computer print-out; for computer input or interrogation when the machine is furnished with a keyboard; as a monitor for high-speed tape-to-tape systems (such as those employing Teletype Telespeed equipment available in operating speed of 750, 1050, 1200 words per minute); and as terminal gear for communicating over voice grade channels.

A key operating advantage of the Inktronic is its unrestricted message format. The basic speed is such that each character is printed as it is received. Unlike most high-speed printers which must store received characters until a full line is available for simultaneous print-out, the machine utilizes no buffer storage. It is able to intermingle short and long printed lines without the use of "fill" characters.

The machine prints any number of alphanumeric characters up to 64 depending upon the code used. It is available for use with either the five-level Baudot code or the United States of America Standard Code for Information Interchange (ASCII).

Printing on the unit is done by a stream of highly charged ink particles that are deflected electrostatically to trace out desired characters, in much the same way that a beam of electrons traces patterns on an oscilloscope tube. For each character a jet of ink is drawn out of a nozzle when a suitable voltage is applied to its corresponding valving electrode. (See Figs. 1 and 2.) Changing voltages applied to the vertical and horizontal deflection electrodes deflect the ink jet to trace out the desired character. The initial Inktronic Printer will be capable of printing 80 characters in a line.

Information necessary to guide the ink jet beams through their character tracing patterns is stored in a transformer core memory system. Using this system, it is possible to interchange character fonts in a few minutes.

The printer has few moving parts, practically eliminating the need for mechanical maintenance. The ink used is easier to load than a typewriter ribbon and costs no more. Since the printing process involves no mechanical impact, the machine is virtually noiseless.

Teletype officials describe development of Inktronic equipment as a dramatic step toward helping to solve data communications problems caused by the "information explosion." Information generated by business and government has been expanding at a phenomenal rate, creating an urgent need for increasingly faster

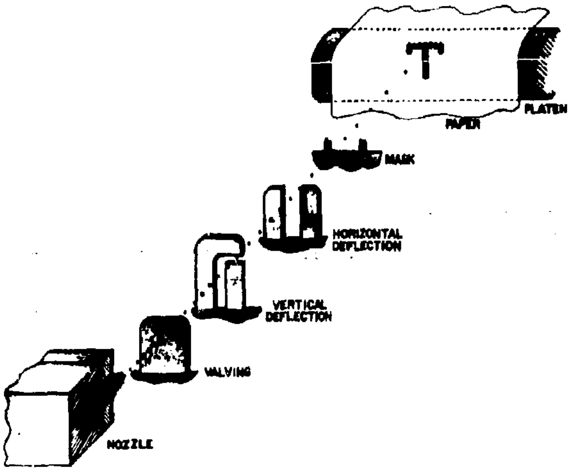

Fig. 1 - The new Teletype Corporation Inktronic page printer forms characters from electronically controlled jets of ink at speeds up to 120 characters per second (1,200 words per minute).

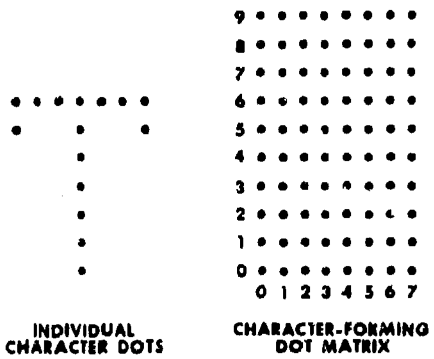

Fig. 2 - A close examination of a character printed on the new Teletype Corporation Inktronic page printer shows that each character is made up of a series of dots of ink.

communications machines. This fact is particularly significant in view of predictions that the transmission of pure data will surpass that of voice messages within the next 10 years.

Teletype Corporation, which is a Bell System unit, is today the largest single company dedicated exclusively to the manufacture of data communications equipment. Its broad line of products range from conventional page printers to complex transmission units. Application is found in such diverse fields as industry, medicine, education, transportation, government, and the military.

Details on the new Inktronic page printer are contained in an information sheet available from Teletype Corporation, Dept. SP 67, 5555 Touhy Avenue, Skokie, Illinois 60076.

The Inktronic page printer provides printed page copy from sequential or parallel binary DC signals. Printing is accomplished a character at a time by a unique electrostatic process that permits operation up to 1200 words-per-minute. This is 12 times the speed of the widely used 100 wpm mechanical page printers.

Electronics associated with the printer are contained in a cleanly styled modern cabinet. The printer, with its associated paper supply and optional paper winder, is located on top of the cabinet. Modular construction of the electrical and mechanical assemblies facilitate maintenance. The electronics have been designed for easy maintenance in the field by personnel with limited skill and without the need for oscilloscopes or other sophisticated equipment.

FEATURES AFFECTING APPLICATION

Speed: Bit timer for operation at 1050 wpm provides compatibility with 1050 wpm tape-to-tape systems. Other timers can be furnished up to a maximum speed of 1200 wpm.

Code: At 1200 wpm: 8-level ASCII, 10.0 unit code, 1200 band; 5-level, 7.0 unit code, 840 band.

Printer: Friction feed platen (sprocket feed platen to be available). Maximum line of print 72 or 80 characters (customer option). Horizontal spacing 10 characters per inch. Vertical spacing 6 lines per inch. Up to 64 alphanumerics can be printed.

Paper: Standard 8-1/2 inch wide teletypewriter paper, 4-1/2 inch to 5 inch diameter roll.

Ink Supply: A pint of ink will print approximately 200 rolls of paper printing 80 character lines.

Floor Space: Cabinet and cover combination measures 18 inches wide by 27 inches deep with an overall height of 47 inches. The unit weighs 380 pounds.

Power Required: Approximately 600 watts, 115 V, 60 Hz. Set is fused for 8 amperes.

Interface Information:

Signal Line: With proper data set, can transmit over regular telephone lines. Optional coupler for EIA Standard RS-232B Interface.

The electronics have been designed on a modular basis to provide reduced maintenance time by proving for rapid, plug-in, replacement of parts. A further advantage is that a variety of applications may be satisfied using a small inventory of modular assemblies to provide for variations. The number of adjustments has been held to a minimum. Extensive use of integrated circuits keeps size, weight, and cost to a minimum.

USAGE CONSIDERATIONS

Paper Roll Replacement: A standard 400-foot roll of paper will last for up to 5 hours, 1050 wpm when printing 80 character lines.

Multiple copies: The Inktronic Printer produces a single copy; this copy may be readily reproduced in any desired quantity using ordinary office copiers.

* * *

Computer Applications and Expansion Plans

Wayne State University
Detroit, Michigan 48202

Laboratory animals that spent their entire lives breathing polluted air showed few effects traceable to pollution, states a soon-to-be issued report prepared by Wayne State Univesitv.

The report, compiled and evaluated on an IBM computer, will be submitted to the U.S. Public Health Service. It is based on a recently concluded 5-year study by the University under the direction of Dr. Ralph Smith, professor, occupational and environmental health in WSU's School of Medicine.

The study was performed under the terms of a contract with the Public Health Service.

Dr. Smith explains that during the experiment, continuous checks were made of the amount of pollution being inhaled by two test colonies of animals, consisting of rats, guinea pigs, and rabbits.

Eight automatic instruments continuously monitored the air, measuring it for the content of nitrogen dioxide, nitric oxide, sulfur dioxide, oxidant, carbon monoxide, carbon dioxide, hydrocarbons, and aerosol. The measured results were then processed through the University's IBM 7074 computer for evaluation and reporting.

One of the groups of animals was exposed to air pumped in from a duct above a heavily traveled street. The other group breathed only air purified by activated charcoal, and passed through filters to remove all particles.

Animals born and raised in the laboratory were examined at the time of their natural death.

Dr. Smith concludes that the study did not support the contention that breathing polluted air at the levels measured is harmful to health, though extrapolation of such findings to humans must obviously be made with caution. "One of the few indications of any changes due to air pollution was a small increase in the white blood cell count of the exposed groups, a condition that does not imply deterioration in health."

Dr. Smith explained that the body normally attacks foreign materials, in this case those inhaled, with white blood cells. This would explain the higher count of white blood cells in the rodents, he said.

He stated the experiment was not conducted on humans, but noted that the body of man has a more sophisticated respiratory and filtering system than that of rodents.

Dr. Walter Hoffman, director of WSU's computing and data processing center, said that it would have been impossible to gather, analyze and compile the massive amounts of information obtained in the 5-year study without computer assistance.

The recently concluded study is one of a number of research, academic, and other educational programs being conducted at the school with the assistance of the University's computer center. Computers in use at the center include an IBM 7074 and a more powerful IBM System/360 Model 50.

Dr. Hoffman explained that the instruments measuring air pollutants during the 5-year study produced a running punched paper tape. This was transported to the computer center, converted to magnetic tape and computer processed. At the end of each day, the computer produced a print-out of the day's measurement, showing the peaks and valleys of air pollution hour by hour.

Dr. Hoffman explained that a more sophisticated computer complex scheduled for installation beginning in November would facilitate even more ambitious use by students and faculty.

A total of 50 Tele-processing terminals, some equipped with keyboards and printing units, and others equipped with keyboards and TV-like screens, soon will be installed to enable students and faculty to use a computer for university-related work from remote locations across the campus.

The terminals will make it possible to key a problem directly into the computer from the engineering building, for example, and have the answer flashed back in the form of a print-out, all in a matter of seconds.

Dr. Hoffman said, "The fully implemented system will enable students to handle more complex study and research programs to better prepare them for their fields of specialty."